

What is claimed:

1. An increased stiffness of vehicle structure comprising  
a main vehicle body (20) having at least one door aperture (20.1, 20.1B, 20.1T, 20.1h,  
5 20.1x) therein;  
a mating vehicle door (8, 8B, 8T, 8h, 8x), generally representing a tailgate- (8T), sliding  
side-, cargo-, liftgate door, trunk cover (8x), hood (8h) or vehicle door (8, 8B), whose  
door frame, reinforced by at least two impact beams (1, 7, 1B, 7B), spanning the door  
aperture, elements and at least one window-guide channel (6, 6B, 6.1, 6.2, 6.1B, 6.2B,  
10 6.1a, 6.2a, 6.1aB, 6.2aB) to guide and receive a window pane, is hingedly secured to  
that vehicle body (20) for pivotal movement between an open and a closed position;  
interengaging assemblies, each of which includes a key arranged to one of the reinforcing  
members of that door frame, facing a vehicular member of that vehicle body, and a  
mating receptacle located thereon; and  
15 adjusting mechanisms to reduce the clearances between the adjustable keys and the mating  
receptacles to minimum tolerances, when the vehicle door is closed, to ensure the  
engagement of the interengaging assemblies and the connection of the vehicular couples  
consisting of  
vehicle door & vehicle roof (17),  
20 vehicle door & side rail (18),  
vehicle door & pillar and  
vehicle door & flange (21, 21T, 21h, 21x) of the vehicle body (20)  
thus distributing impact energy to all vehicular members, lowering stress thereof and  
preventing passengers from being hurled out of the motor vehicle in the event of an  
25 accident.

2. An increased stiffness of vehicle structure comprising  
a main vehicle body (20) having at least three door apertures (20.1, 20.1B, 20.1T, 20.1h,  
20.1x), two of which are series-connected, therein;  
30 three mating vehicle doors (8, 8B, 8T, 8h, 8x), each of which generally representing a  
tailgate- (8T), sliding side-, cargo-, liftgate door, trunk cover (8x), hood (8h) or vehicle  
door (8, 8B), whose door frame, reinforced by at least two impact beams (1, 7, 1B, 7B),  
spanning the door aperture, elements and at least one window-guide channel (6, 6B, 6.1,  
6.2, 6.1B, 6.2B, 6.1a, 6.2a, 6.1aB, 6.2aB) to guide and receive a window pane, is  
35 hingedly secured to that vehicle body (20) for pivotal movement between an open and a  
closed position;  
interengaging assemblies, each of which includes a key arranged to one of the reinforcing  
members of that door frame, facing a vehicular member of that vehicle body, and a  
mating receptacle located thereon;  
40 at least one extension member (17.3, 18.3, 23), mounted to a common pillar of the series-  
connected vehicle doors, to receive at least two keys mating to the receptacles, located  
on the respective reinforcing members of those doors, when closed, for exploiting the  
constrained deformation thereof to prevent them from popping open in the event of an  
accident; and  
45 adjusting mechanisms to reduce the clearances between the adjustable keys and the mating  
receptacles to minimum tolerances, when the vehicle doors are closed, to ensure the  
engagement of the interengaging assemblies and the connection of the vehicular couples  
consisting of

vehicle door & vehicle roof (17),  
vehicle door & side rail (18),  
vehicle door & pillar,  
series-connected vehicle doors & common pillar and  
5 vehicle door & flange (21, 21T, 21h, 21x) of the vehicle body (20)  
thus distributing impact energy to all vehicular members, lowering stress thereof and  
preventing passengers from being hurled out of the motor vehicle in the event of an  
accident.

10 3. An increased stiffness of vehicle structure comprising

a main vehicle body (20) having at least one door aperture (20.1, 20.1B, 20.1T, 20.1h,  
20.1x) therein;

a mating vehicle door (8, 8B, 8T, 8h, 8x), generally representing a tailgate- (8T), sliding  
side-, cargo-, liftgate door, trunk cover (8x), hood (8h) or vehicle door (8, 8B), whose  
15 door frame, reinforced by at least two impact beams (1, 7, 1B, 7B), spanning the door  
aperture, elements and at least one window-guide channel (6, 6B, 6.1, 6.2, 6.1B, 6.2B,  
6.1a, 6.2a, 6.1aB, 6.2aB) to guide and receive a window pane, is hingedly secured to  
that vehicle body (20) for pivotal movement between an open and a closed position;

interengaging assemblies, each of which includes a key arranged to one of the reinforcing  
20 members of that door frame, facing a vehicular member of that vehicle body, and a  
mating receptacle located thereon; and

adjusting mechanisms to reduce the clearances between the adjustable keys and the mating  
receptacles to permissible tolerances, when the vehicle door is closed, to ensure the  
engagement of the interengaging assemblies and the connection of the vehicular couples,  
25 at least one thereof has a plurality of interengaging assemblies operating at least at two  
planes, consisting of

vehicle door & vehicle roof (17),

vehicle door & side rail (18),

vehicle door & pillar and

30 vehicle door & flange (21, 21T, 21h, 21x) of the vehicle body (20)

thus distributing impact energy to all vehicular members, lowering stress thereof and  
preventing passengers from being hurled out of the motor vehicle in the event of an  
accident.

35 4. An increased stiffness of vehicle structure comprising

a main vehicle body (20) having at least one door aperture (20.1, 20.1B, 20.1T, 20.1h,  
20.1x) therein;

a mating vehicle door (8, 8B, 8T, 8h, 8x), generally representing a tailgate- (8T), sliding  
side-, cargo-, liftgate door, trunk cover (8x), hood (8h) or vehicle door (8, 8B), whose  
40 door frame, reinforced by at least two impact beams (1, 7, 1B, 7B), spanning the door  
aperture, elements and at least one window-guide channel (6, 6B, 6.1, 6.2, 6.1B, 6.2B,  
6.1a, 6.2a, 6.1aB, 6.2aB) to guide and receive a window pane, is hingedly secured to  
that vehicle body (20) for pivotal movement between an open and a closed position;

interengaging assemblies, each of which includes a key arranged to one of the reinforcing  
45 members of that door frame, facing a vehicular member of that vehicle body, and a  
mating receptacle located thereon, when the vehicle door is closed, to ensure the  
engagement of the interengaging assemblies and the connection of the vehicular couples,  
at least one thereof has a plurality of interengaging assemblies operating at least at two  
planes, consisting of

vehicle door & vehicle roof (17),  
vehicle door & side rail (18),  
vehicle door & pillar and  
vehicle door & flange (21, 21T, 21h, 21x) of the vehicle body (20)

5 thus distributing impact energy to all vehicular members, lowering stress thereof and preventing passengers from being hurled out of the motor vehicle in the event of an accident.

10 5. An increased stiffness of vehicle structure comprising  
a main vehicle body (20) having at least three door apertures (20.1, 20.1B, 20.1T, 20.1h, 20.1x), two of which are series-connected, therein;  
three mating vehicle doors (8, 8B, 8T, 8h, 8x), each of which generally representing a  
tailgate- (8T), sliding side-, cargo-, liftgate door, trunk cover (8x), hood (8h) or vehicle  
15 door (8, 8B), whose door frame, reinforced by at least two impact beams (1, 7, 1B, 7B),  
spanning the door aperture, elements and at least one window-guide channel (6, 6B, 6.1, 6.2, 6.1B, 6.2B, 6.1a, 6.2a, 6.1aB, 6.2aB) to guide and receive a window pane, is  
hingedly secured to that vehicle body (20) for pivotal movement between an open and a closed position;  
at least one extension member (17.3, 18.3, 23), mounted to a common pillar of the series-  
20 connected vehicle doors, to receive at least two keys mating to the receptacles, located on the respective reinforcing members of those doors, when closed, for exploiting the constrained deformation thereof to prevent them from popping open in the event of an accident; and  
interengaging assemblies, each of which includes a key arranged to one of the reinforcing  
25 members of that door frame, facing a vehicular member of that vehicle body, and a mating receptacle located thereon, when the vehicle door is closed, to ensure the engagement of the interengaging assemblies and the connection of the vehicular couples, at least one thereof has a plurality of interengaging assemblies operating at least at two planes, consisting of  
30 vehicle door & vehicle roof (17),  
vehicle door & side rail (18),  
vehicle door & pillar,  
series-connected vehicle doors & common pillar and  
vehicle door & flange (21, 21T, 21h, 21x) of the vehicle body (20)  
35 thus distributing impact energy to all vehicular members, lowering stress thereof and preventing passengers from being hurled out of the motor vehicle in the event of an accident.

40 6. An increased stiffness of vehicle structure according to claim 1, wherein the interengaging assembly of vehicle door & vehicle roof (17) consists of  
at least two hooks (15.6) mounted to the window-guide channels (6.1a, 6.2a, 6.3, 6.4 or 6.1aB, 6.2aB, 6.3B, 6.4B); and  
a mating rod (17.1d) arranged along that vehicle roof and mounted to two transverse  
45 girders (17.2e, 17.2f, 17.2g) connecting the pillars of both vehicle sides to each other.

7. An increased stiffness of vehicle structure according to claim 1, wherein the interengaging assembly of vehicle door & side rail (18) consists of at least two hooks (15.6) mounted to the window-guide channels (6.1a, 6.2a, 6.3, 6.4 or 6.1aB, 6.2aB, 6.3B, 6.4B); and  
5 a mating rod (17.1d) arranged along that side rail and mounted to two transverse girders (17.2e, 17.2f, 17.2g) connecting the pillars of both vehicle sides to each other.

8. An increased stiffness of vehicle structure according to claim 1, wherein the interengaging assemblies of series-connected vehicle doors & vehicle roof (17) and series-  
10 connected vehicle doors & side rail (18) consist of at least eight hooks (15.6) mounted to the corresponding window-guide channels; and two mating rods (17.1d) arranged along that vehicle roof and side rail and mounted to three transverse girders (17.2e, 17.2f, 17.2g), connecting all pillars of both vehicle sides to each other.

9. An increased stiffness of vehicle structure according to claim 1, wherein the adjustable interengaging assembly of vehicle door & pillar, whereto the door hinges are fastened, consists of  
15 a key (15.1) bolted to the intersection region of the pillar and roof, which is reinforced by a plate (17.1c) and transverse girder (17.2d), connecting the pillars of both vehicle sides to each other; and  
20 a mating hole arranged to the window-guide channel (6.1a, 6.2a, 6.1aB, 6.2aB).

10. An increased stiffness of vehicle structure according to claim 1, wherein the adjustable interengaging assemblies of vehicle door & vehicle roof consist of  
25 a key (15.2a), bolted to an element (6.11) rigidly attached to the respective window-guide channel (6.1a, 6.2a, 6.3, 6.4, 6.1aB, 6.2aB, 6.3B, 6.4B), and a plurality of keys (15.2), bolted to the respective window-guide channels; and  
30 mating holes arranged to the vehicle roof (17), reinforced by a plate (17.1, 17.1a) and transverse plate (17.2a) connecting the pillars of both vehicle sides to each other.

11. An increased stiffness of vehicle structure according to claim 1, wherein the interengaging assemblies of vehicle door & side rail consist of  
35 a plurality of keys (15.4, 15.4a) mounted to the respective window-guide channels (6.1a, 6.2a, 6.3, 6.4, 6.1aB, 6.2aB, 6.3B, 6.4B); and  
mating holes arranged to the side rail (18) reinforced by an element (18.1, 18.1a).

12. An increased stiffness of vehicle structure according to claim 1, wherein the interengaging assemblies of vehicle door & vehicle roof and vehicle door & side rail consist  
40 of a plurality of keys (15.2, 15.4, 15.4a) mounted to the respective window-guide channels (6.1a, 6.2a, 6.3, 6.4, 6.1aB, 6.2aB, 6.3B, 6.4B); and  
mating holes arranged to the vehicle roof (17), reinforced by the plate (17.1a), and to the  
45 side rail (18), reinforced by an element (18.1, 18.1a).

13. An increased stiffness of vehicle structure according to claim 1, wherein the adjustable interengaging assemblies of vehicle doors & flange (21) of the vehicle body (20) consist of a plurality of keys (30, 32, 35) bolted to the reinforced flange (21) of the vehicle body (20); and

5 mating holes arranged to the housings (6.5, 6.5B) rigidly attached to the window-guide channels (6, 6B), retaining members (6.6b, 6.7b, 6.8) and impact beams (7, 7B), respectively.

10 14. An increased stiffness of vehicle structure according to claim 1, wherein the key (15.6), adjustable from outside the vehicle, comprises a bolt (15.21), a number of spacers (15.22), washer (15.24), nut (15.25) and a hook (15.6) with interior diameter ( $d_1$ ) and gap ( $s_1$ ).

15 15. An increased stiffness of vehicle structure according to claim 1, wherein the key, adjustable from outside the vehicle, comprises a bolt (15.14), large washer (15.13) with outer diameter (D), a number of spacers (15.12) and a sleeve (15.11), both have a total length (l).

20 16. An increased stiffness of vehicle structure according to claim 15, wherein the sleeve (15.11) of the key with exterior diameter (d) is governed by the equation ( $D \geq d \geq d_R$ ), where (D) is the exterior diameter of washer (15.13) and ( $d_R$ ) is the diameter of spacer (15.12) and sleeve.

25 17. An increased stiffness of vehicle structure according to claim 15, wherein the front region of washer (15.13) has radial teeth.

18. An increased stiffness of vehicle structure according to claim 15, wherein the washer is an integral part of the bolt.

30 19. An increased stiffness of vehicle structure according to claim 1, wherein both ends of the U-shaped window-guide channel (6, 6B), facing the lower vehicular member of the vehicle body (20), and an upper portion of that window-guide channel, facing the upper vehicular member of the vehicle body (20), accommodate the members of interengaging assemblies.

35 20. An increased stiffness of vehicle structure according to claim 19, wherein both ends of the respective stiff U-shaped window-guide channel (6, 6B) are connected to each other by a window-guide member (6.4, 6.4B).

40 21. An increased stiffness of vehicle structure according to claim 1, wherein the window-guide channels (6.1, 6.2, 6.1B, 6.2B) are rigidly attached to the respective stiff window-guide members (6.1a, 6.2a, 6.1aB, 6.2aB).

45 22. An increased stiffness of vehicle structure according to claim 1, wherein the adjustable interengaging assemblies of vehicle door & pillar, whereto the vehicle door hinges are fastened, consist of a plurality of keys (31, 36) bolted to a retaining member (6.6a, 6.8), rigidly attached to the window-guide channel (6, 6B), and impact beams (1, 1B, 7, 7B); and mating holes arranged to the pillar reinforced by an extension member (23).

50 23. An increased stiffness of vehicle structure according to claim 2, wherein the adjustable interengaging assemblies of series-connected vehicle doors & common pillar are defined by at least one pair of keys (15.3, 15.3a) bolted to both legs of the U-shaped extension member (17.3), mounted to the common pillar, reinforced by a plate (17.1b), arranged

along the vehicle roof (17) and attached rigidly to a transverse girder (17.2c), connecting the common pillars of both vehicle sides to each other; and mating holes arranged to both window-guide channels of series-connected vehicle doors adjacent to that common pillar.

24. An increased stiffness of vehicle structure according to claim 2, wherein the adjustable interengaging assemblies of series-connected vehicle doors & common pillar are defined by at least one pair of keys (15.5, 15.5a) bolted to both legs of the U-shaped extension member (18.3) mounted to the common pillar, reinforced by an element (18.1b), arranged along the side rail (18) and attached rigidly to a transverse girder (18.2), connecting the common pillars of both vehicle sides to each other; and mating holes arranged to both window-guide channels of series-connected vehicle doors adjacent to that common pillar.

25. An increased stiffness of vehicle structure according to claim 24, wherein a belt case (26) is accommodated in the U-shaped extension member (18.3).

26. An increased stiffness of vehicle structure according to claim 3, wherein the adjustable interengaging assemblies of vehicle door (8) & pillar, operating in two planes, are defined by a plurality of keys (33) bolted to the window-guide channel and a plurality of keys (34), bolted to a retaining members (6.7a), rigidly attached to the window-guide channel (6) and impact beams (1, 7); and the mating receptacles arranged to the reinforced pillar.

27. An increased stiffness of vehicle structure according to claim 3, wherein the adjustable interengaging assemblies of vehicle door (8, 8B) & pillar, operating in three planes, are defined by a plurality of keys (15.1) rigidly arranged to the reinforced pillar, whereto the door frame is hingedly secured, and a plurality of keys (30, 31, 35, 36), rigidly arranged to the reinforced flange (21) of the vehicle body (20); and the mating receptacles arranged to retaining members (6.6a, 6.8), housings (6.5, 6.5B) and the window-guide channel (6.1a, 6.2a), respectively.

28. An increased stiffness of vehicle structure according to claim 4, wherein the interengaging assemblies of vehicle door (8, 8B) & vehicle roof (17), operating in four planes, are defined by a plurality of keys (15.2, 15.2a) rigidly arranged to the respective window-guide channels (6.1a, 6.2a, 6.3, 6.4, 6.1aB, 6.2aB, 6.3B, 6.4B) and at least two keys (30, 32, 35, 37), rigidly arranged to the reinforced flange (21) of the vehicle body (20); and the mating receptacles arranged to the reinforced vehicle roof (17) and that window-guide channels, respectively.

29. An increased stiffness of vehicle structure according to claim 4, wherein the interengaging assemblies of connecting vehicular couples, operating in many planes, are defined by a plurality of keys (15.1 to 15.7, 30, 32, 35, 37) rigidly arranged to the reinforced pillar, reinforced vehicle roof, reinforced side rail and reinforced flange of vehicle body, respectively; and the mating receptacles arranged to the reinforcing members of vehicle doors, respectively.

30. An increased stiffness of vehicle structure according to claim 5, wherein a member (6.5C), whose contour is adapted to the door-contour, is rigidly attached to the window-guide channel (6B) and impact beams (1B, 7B).

5 31. An increased stiffness of vehicle structure according to claim 30, wherein the adjustable interengaging assemblies consist of  
a plurality of keys (37) bolted to the rear flange (21) of the vehicle body (20) reinforced by  
an element (21.4B, 21.6B, 21.5B); and  
10 mating holes arranged to the door-contour-shaped member (6.5C).

32. An increased stiffness of vehicle structure according to claim 31, wherein the adjustable interengaging assemblies of vehicle door (8, 8B) & side rail (18), operating in three planes, are defined by  
a plurality of keys (15.4a) rigidly arranged to the side rail (18) and at least two keys (30,  
15 32, 35, 37), rigidly arranged to the reinforced flange (21) of the vehicle body (20); and the mating receptacles arranged to housings (6.5, 6.5B), the window-guide channels (6.1a, 6.2a, 6.3, 6.4, 6.1aB, 6.2aB, 6.3B, 6.4B) and door-contour-shaped member (6.5C), respectively.

20 33. An increased stiffness of vehicle structure according to claim 5, wherein the interengaging assemblies of series-connected vehicle doors & common pillar, operating in many planes, are defined by  
a plurality of keys (15.3, 15.3a, 15.5, 15.5a) rigidly arranged to the extension members (17.3, 18.3, 23) of the common pillar and a plurality of keys (33, 34, 36), rigidly  
25 arranged to the reinforcing members of series-connected vehicle doors, respectively; and the mating receptacles arranged to the reinforcing members of series-connected vehicle doors and the reinforced common pillar, respectively.

30 34. An increased stiffness of vehicle structure, characterised by use of metal, compound material, glass fibre reinforced material or non-metal material for material of a key, receptacle, window-guide channel, transverse girder, rod, plate and extension member.